Spring 6-11-2014

How drugs in wastewater enforce advanced drinking water treatment

Bram Martijn
PWN Water Supply Company

how drugs in waste water enforce advanced drinking water treatment

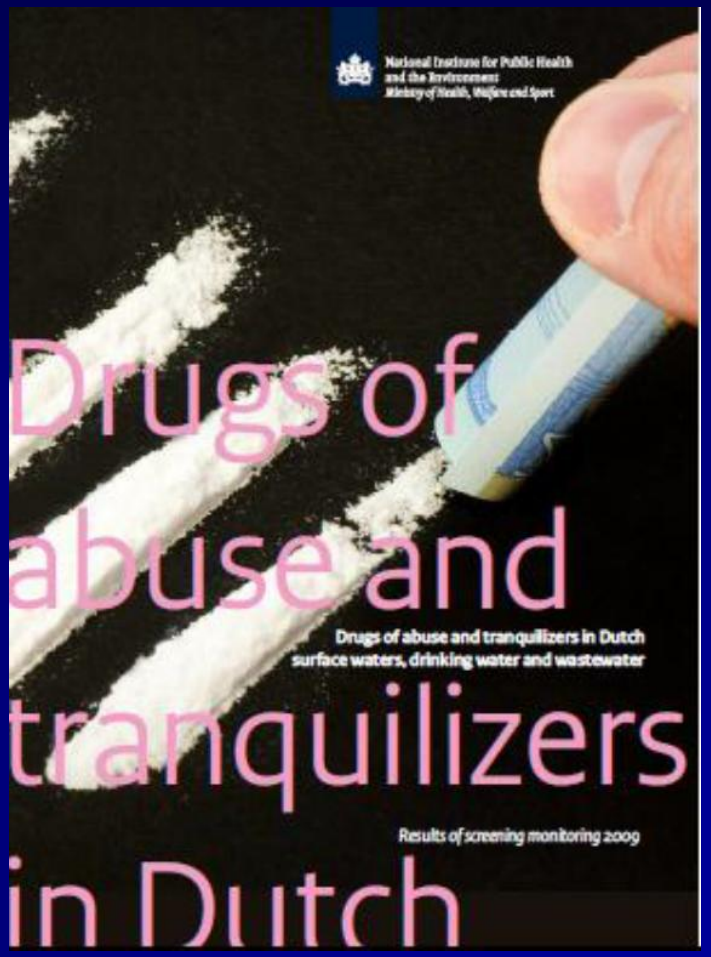
Bram Martijn

PWN Water Supply Company North Holland

The Netherlands

drugs of abuse in (sources of) drinking water!

- surface waters
- drinking water
- sewage water



Van der Aa, Dijkman, Bijlsma, Emke, van de Ven, van Nuijs, de Voogt (2010)

sorry, this presentation is about micropollutants

drugs of abuse, waste water and advanced drinking water treatment

- drugs, pharmaceuticals or pesticides in drinking water (sources) always give rise to media attention
- contribution via domestic waste water no longer to be ignored
- drinking water companies to address this in technology and communications

Facing the Yuck Factor

FEATURE ARTICLE - September 17, 2007 *by Peter Friederici*

Facing the yuck factor. PAUL LACHINE

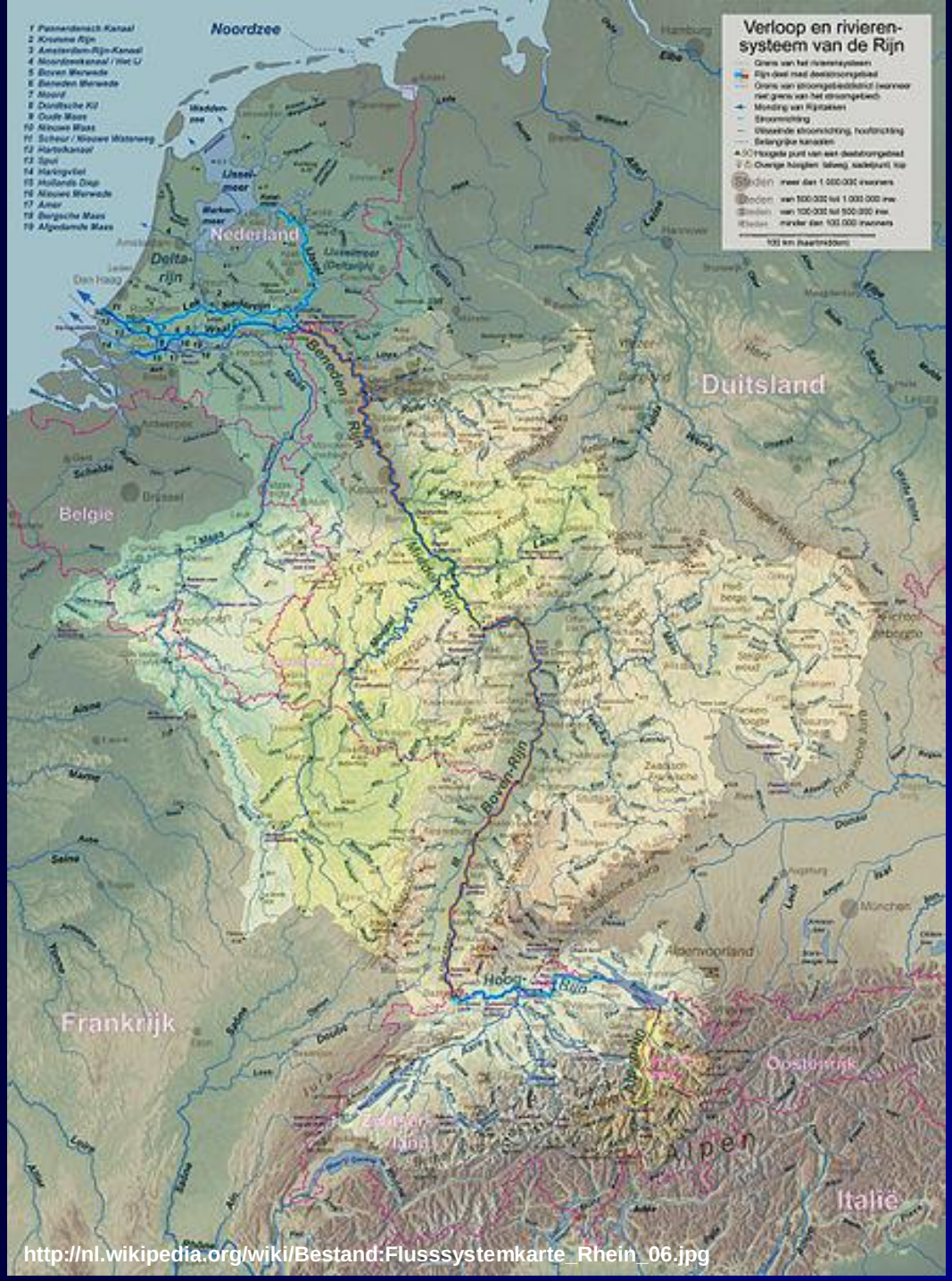
Source: http://www.hcn.org/issues/354/17227

How has the West embraced water recycling? Very (gulp) cautiously

courtesy Dr. Snyder University of Arizona

take home messages

- trace contaminants in drinking water sources via domestic waste water should not be a drinking water treatment problem only, anymore
- tailor available advanced drinking water treament technologies for complex waste water matrix
- modeling is essential in determining where to treat in the water cycle

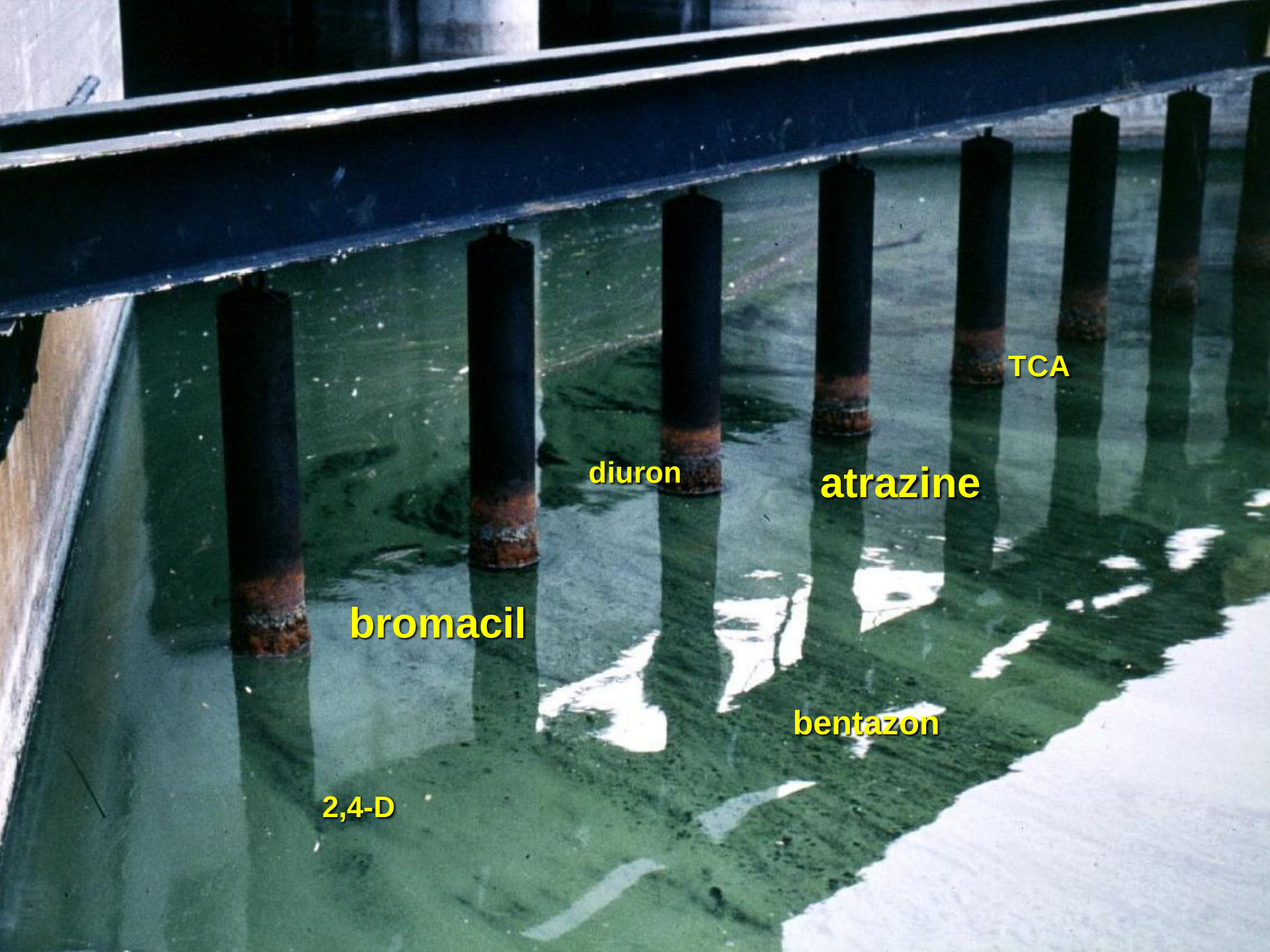


http://nl.wikipedia.org/wiki/Bestand:Flusssystemkarte_Rhein_06.jpg

Rhein


Andijk
WRK III
Bergen
Castricum
Wijk aan Zee
WRK I/II
Rijn


LR 49

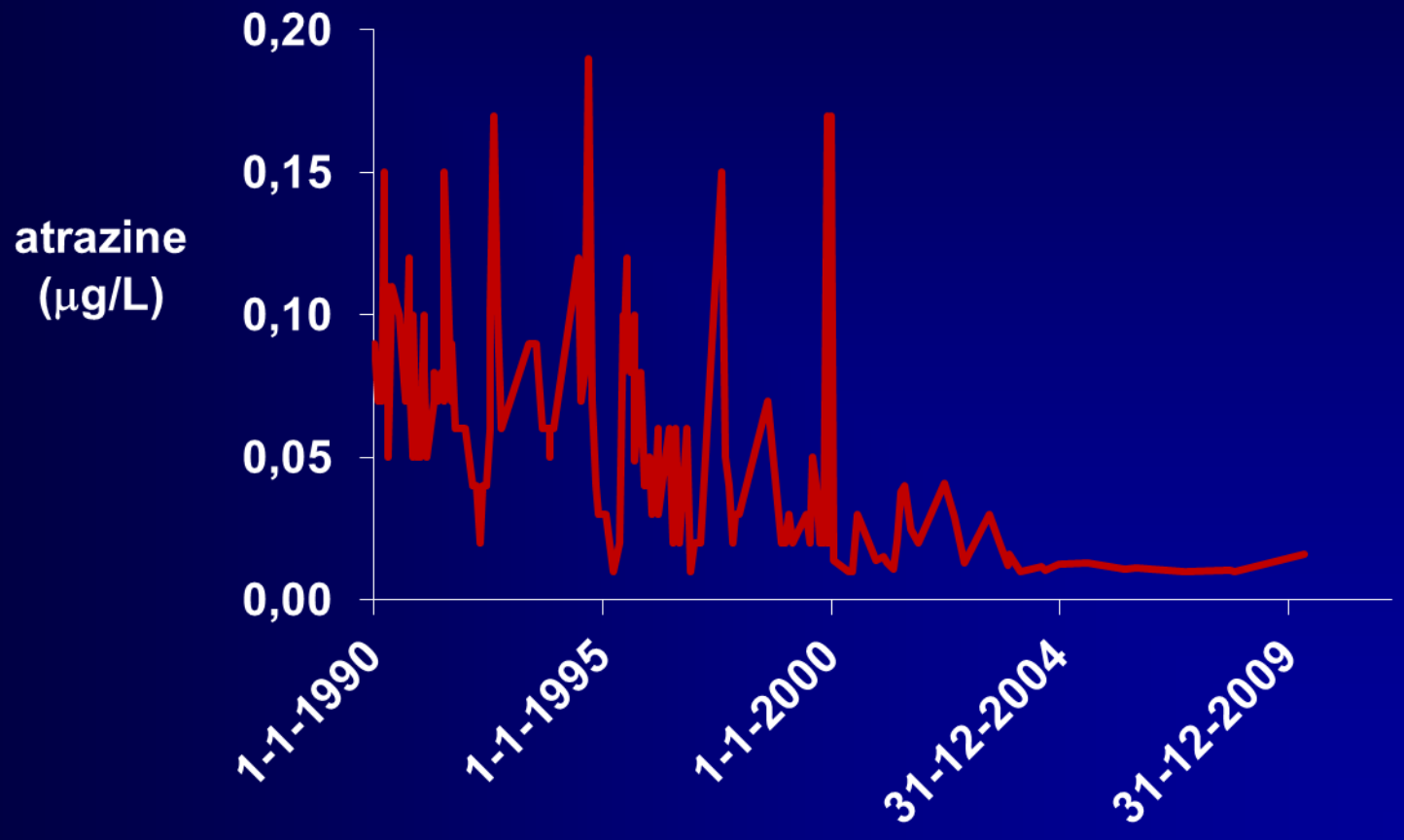

TCA
diuron
atrazine
bromacil
bentazon
2,4-D

characteristics pretreated IJssel Lake water

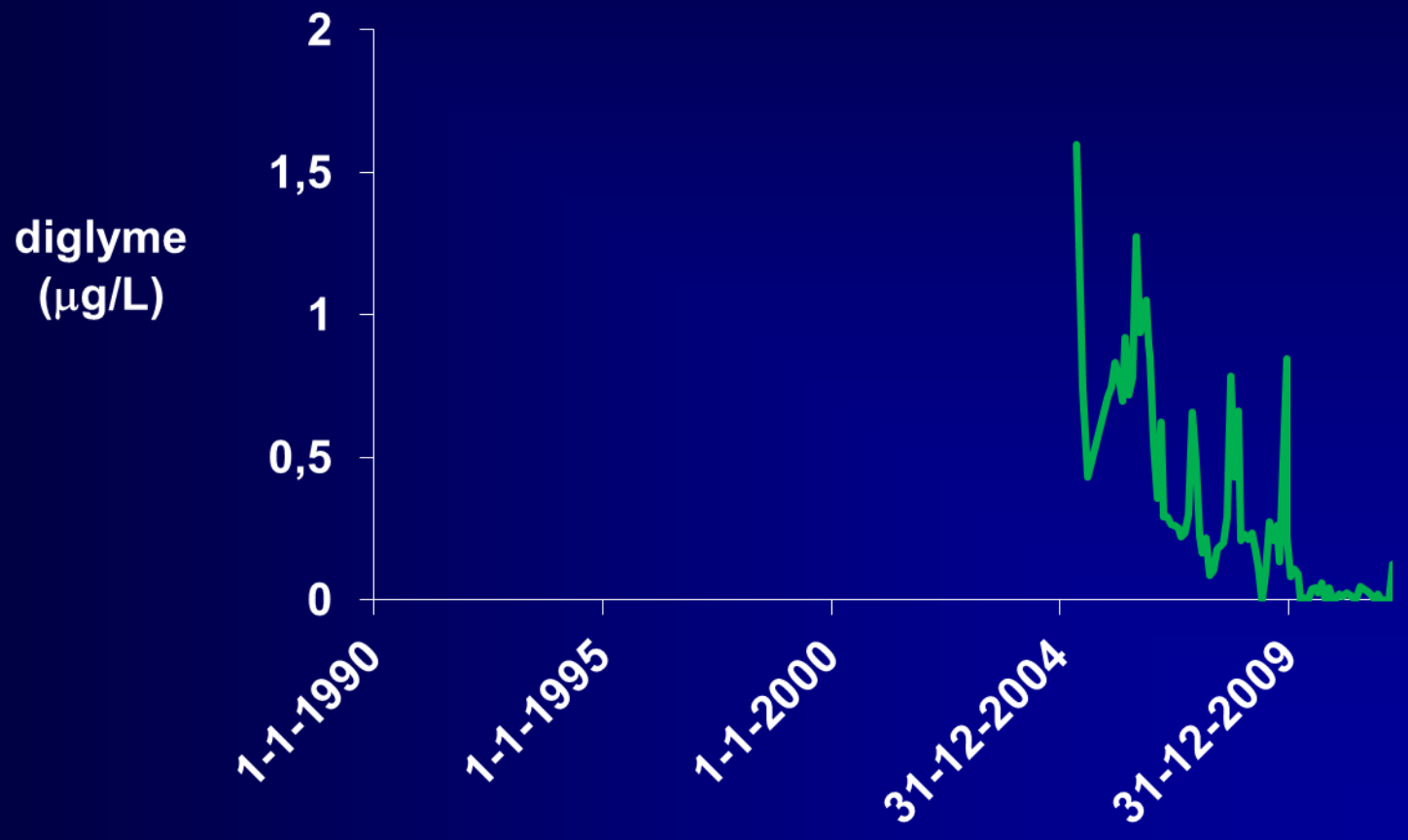
- matrix constituents
  - DOC 2.5 mg C/L
  - nitrate 1-14 mg NO_3/L

- trace chemical contaminants 0-10 µg/L
  - pesticides
  - endocrine disruptors
  - algae toxins
  - solvents, complexing agents
  - pharmaceuticals, personal care products

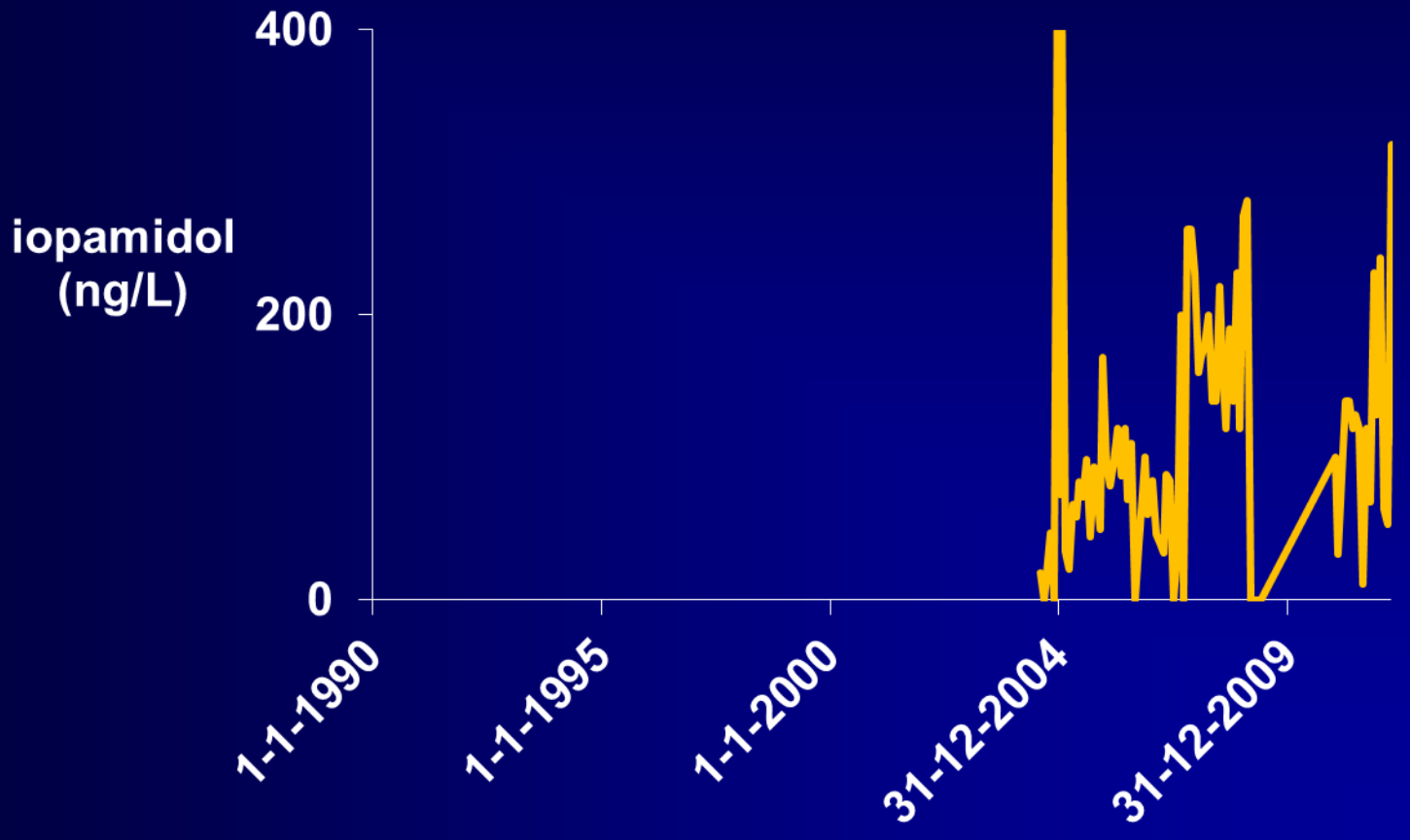
pesticide atrazine in IJssel Lake water



solvent diglyme in IJssel Lake water



röntgen contrast media in IJssel Lake water



how to deal with micropollutants in the source

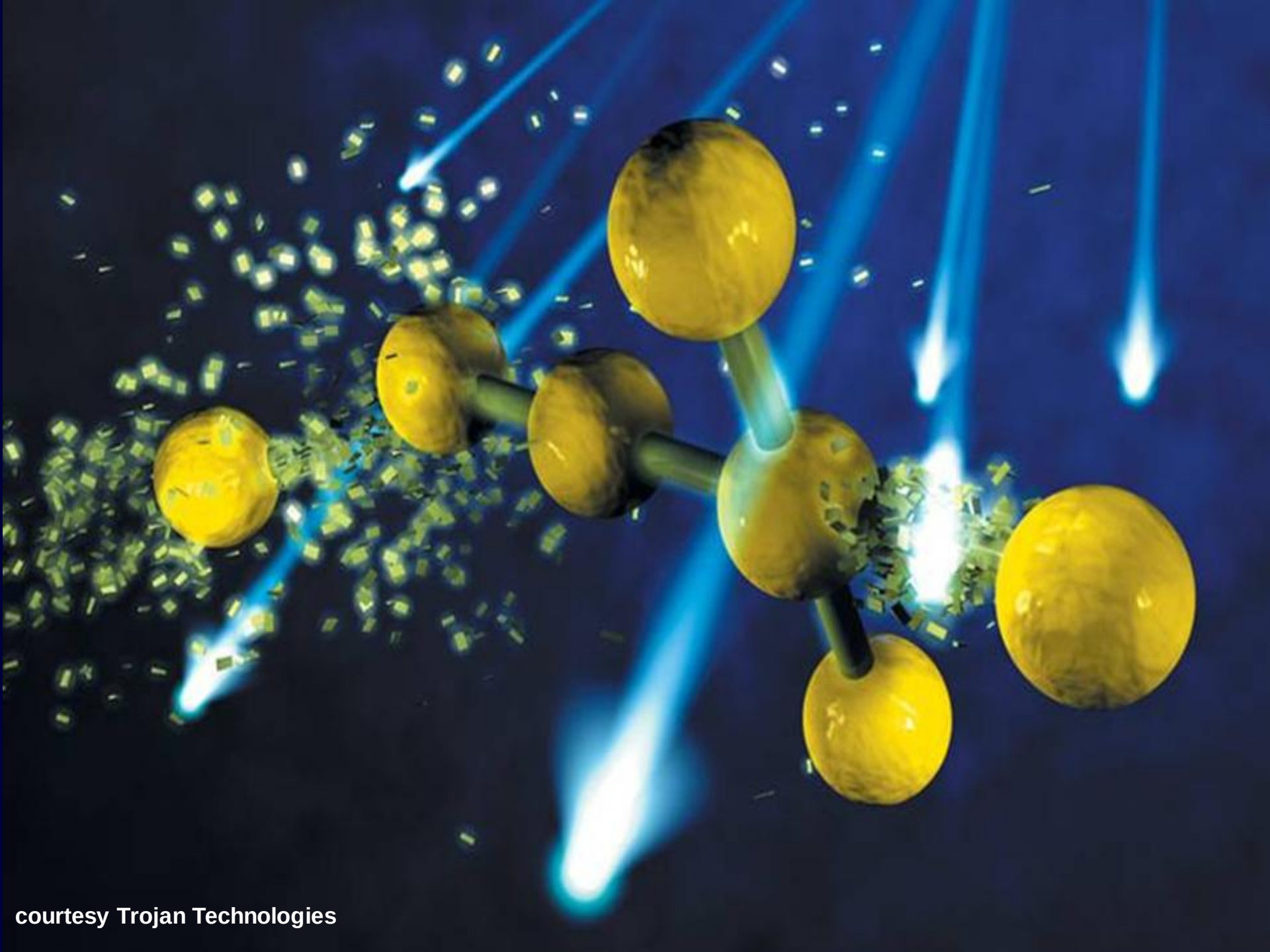
- awareness that waste water is our abundant fresh water source
- end-of-pipe; influence upstream users and dischargers in catchment
  - quality of raw water source ideally only requires simple treatment for drinking water production
- in the mean time act provisionally
  - salt discharge in Rhine by French mining activities enforced DESALINATION of fresh water
  - advanced oxidation in combination wath GAC for organic micropollutant control

approach for organic contaminant control

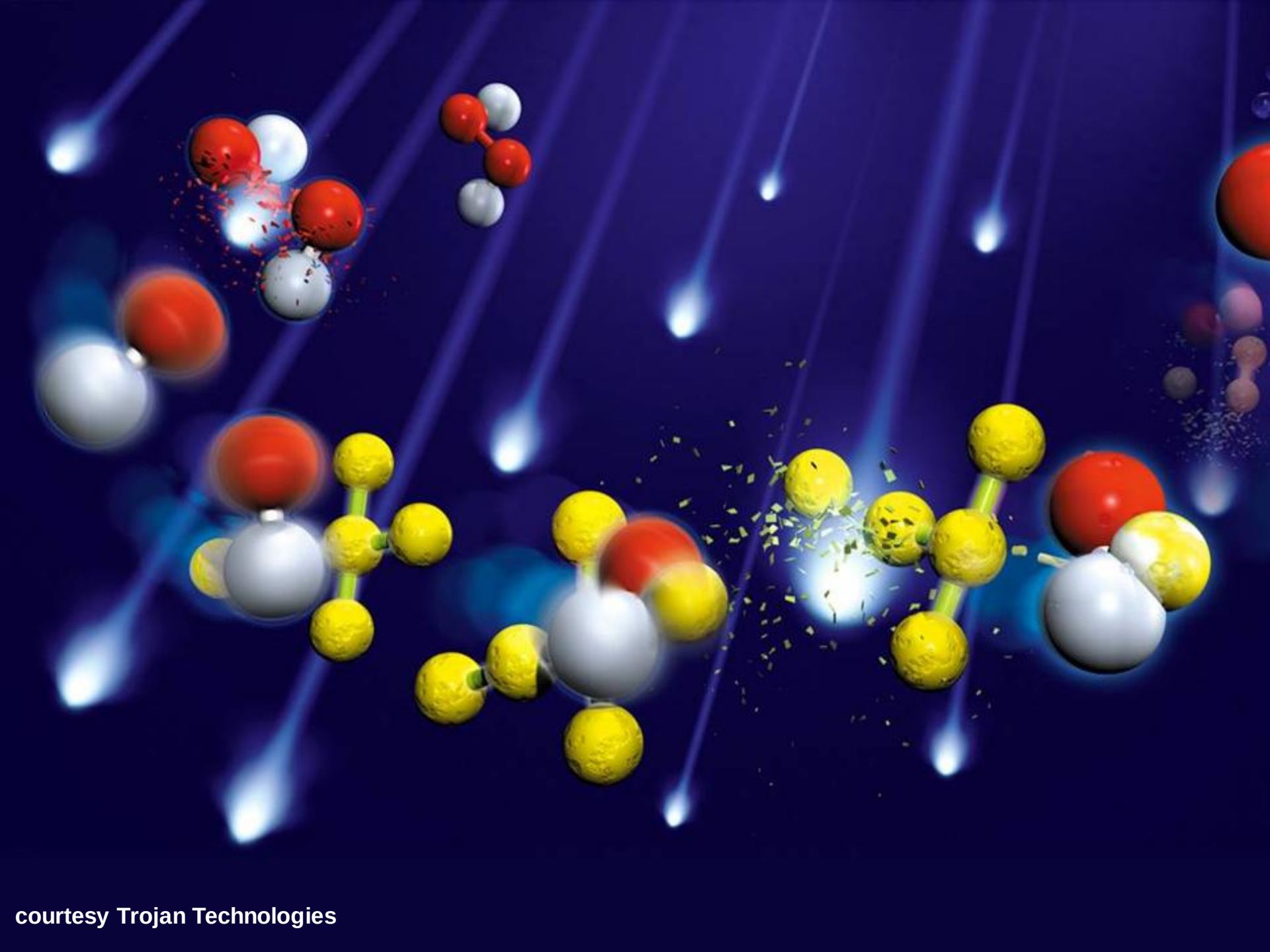
- non selective multibarrier approach against organic micropollutants
- oxidative treatment: MP UV/H_2O_2
- restriction byproduct formation by removal matrix constituents in pretreatment
- restriction byproduct content by post treatment

UV/H_2O_2 treatment for organic contaminant control

- direct UV photolysis, degradation determined by UV absorbance and quantum yield
- OH-radical oxidation, degradation determined by presence of unsaturated sites and H atoms

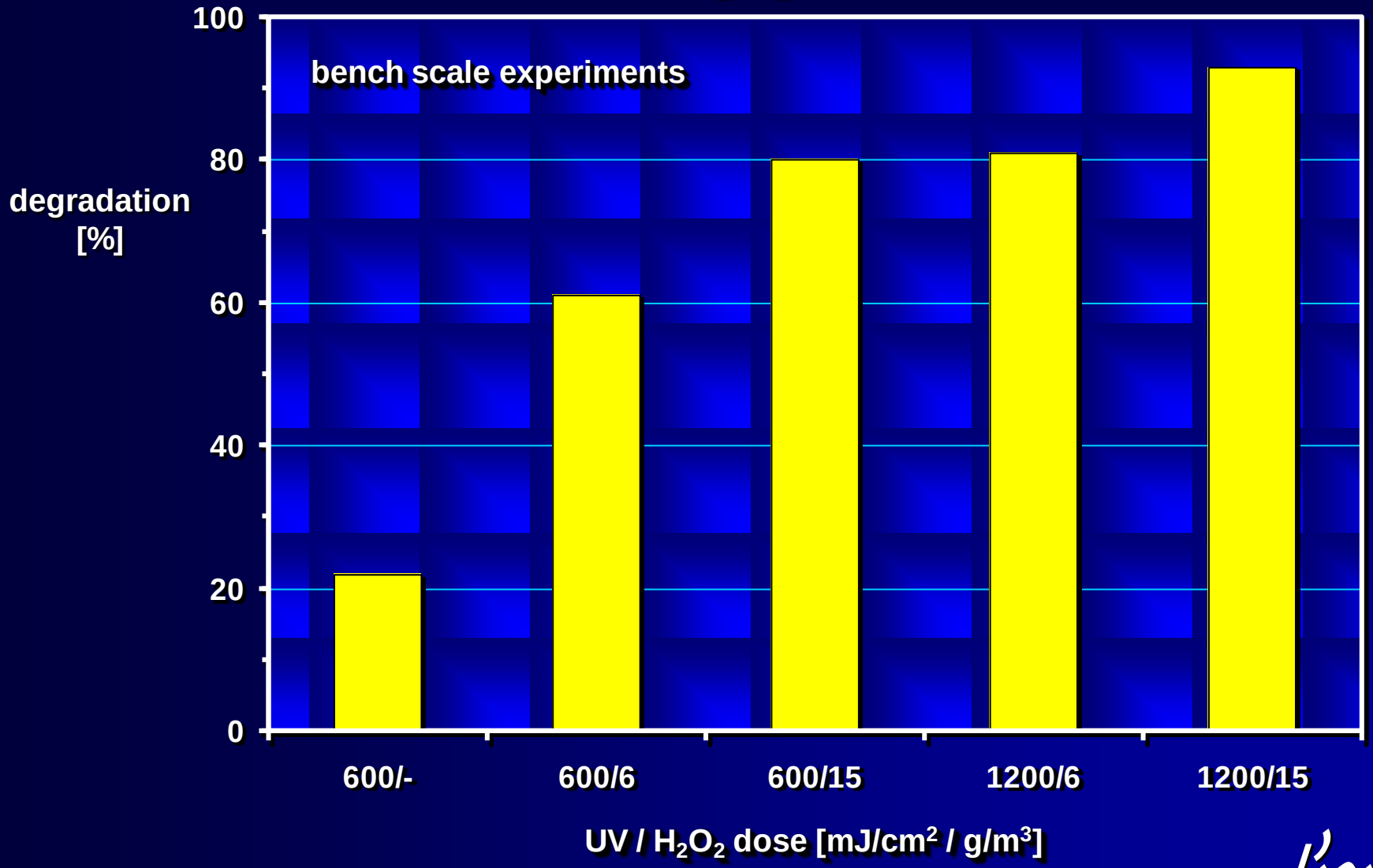


courtesy Trojan Technologies

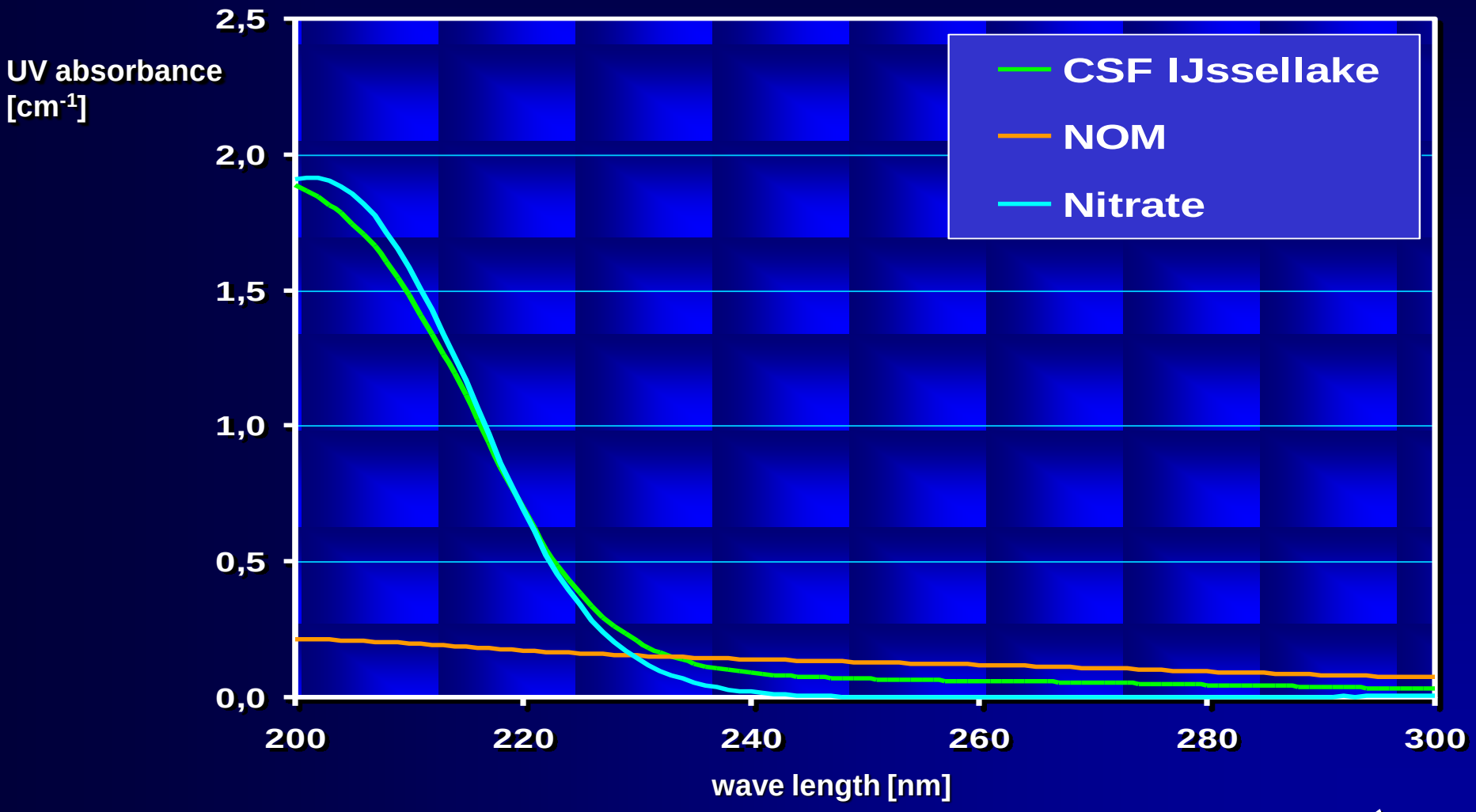


courtesy Trojan Technologies

diglyme degradation by UV photolysis and UV/H_2O_2 oxidation

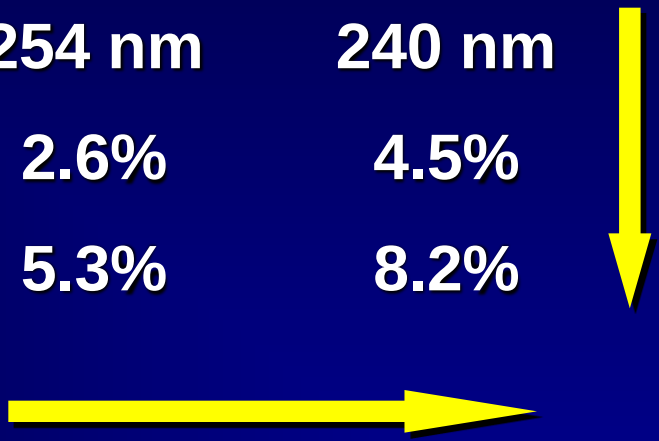


UV absorption spectra



percentage photon flow absorbed in raw, CSF and IX-UF matrix by 6 mg/L H_2O_2

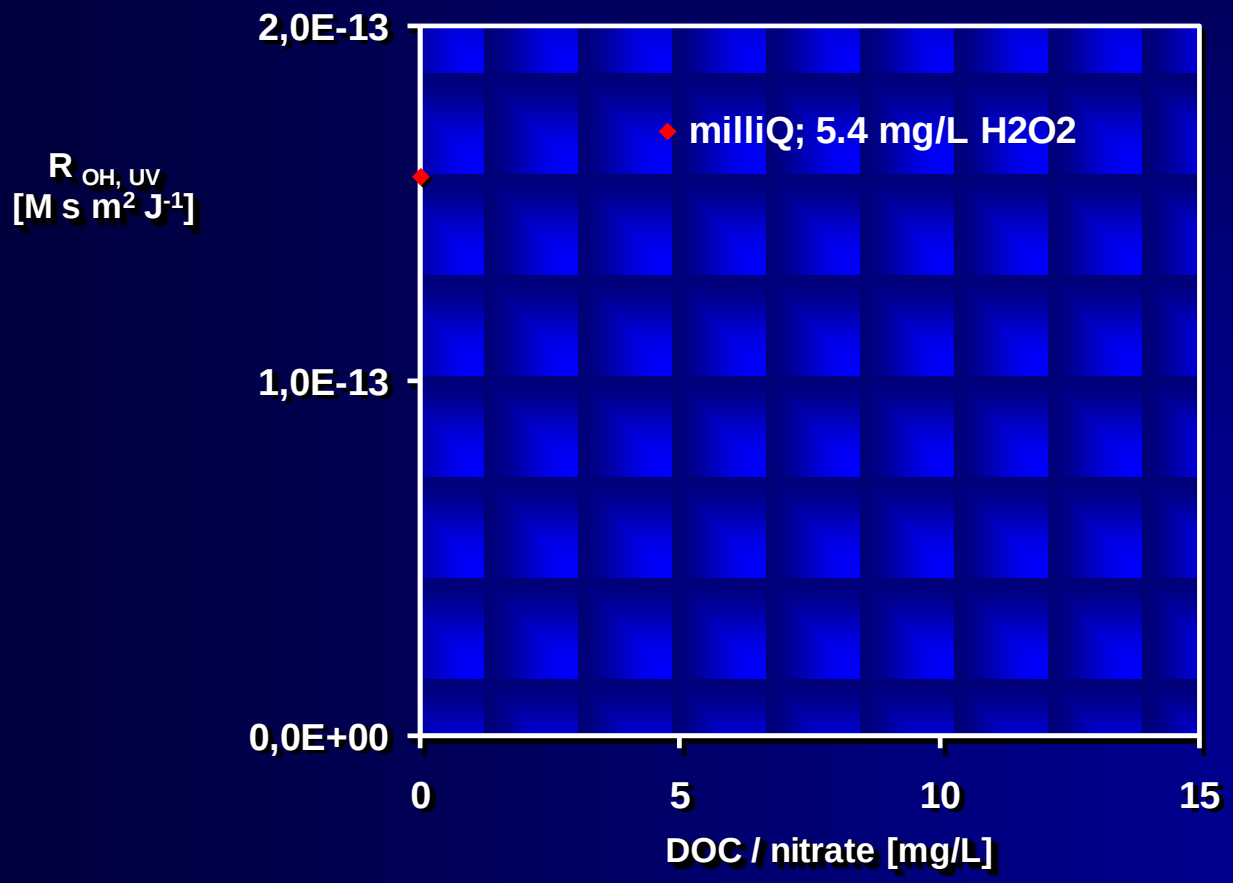
	254 nm	240 nm
raw	2.6%	4.5%
CSF	5.3%	8.2%



increase absorbance H_2O_2 with extended pretreatment

increase absorbance H_2O_2 at lower wave length

radical exposure as a function of DOC and nitrate concentration in milliQ water



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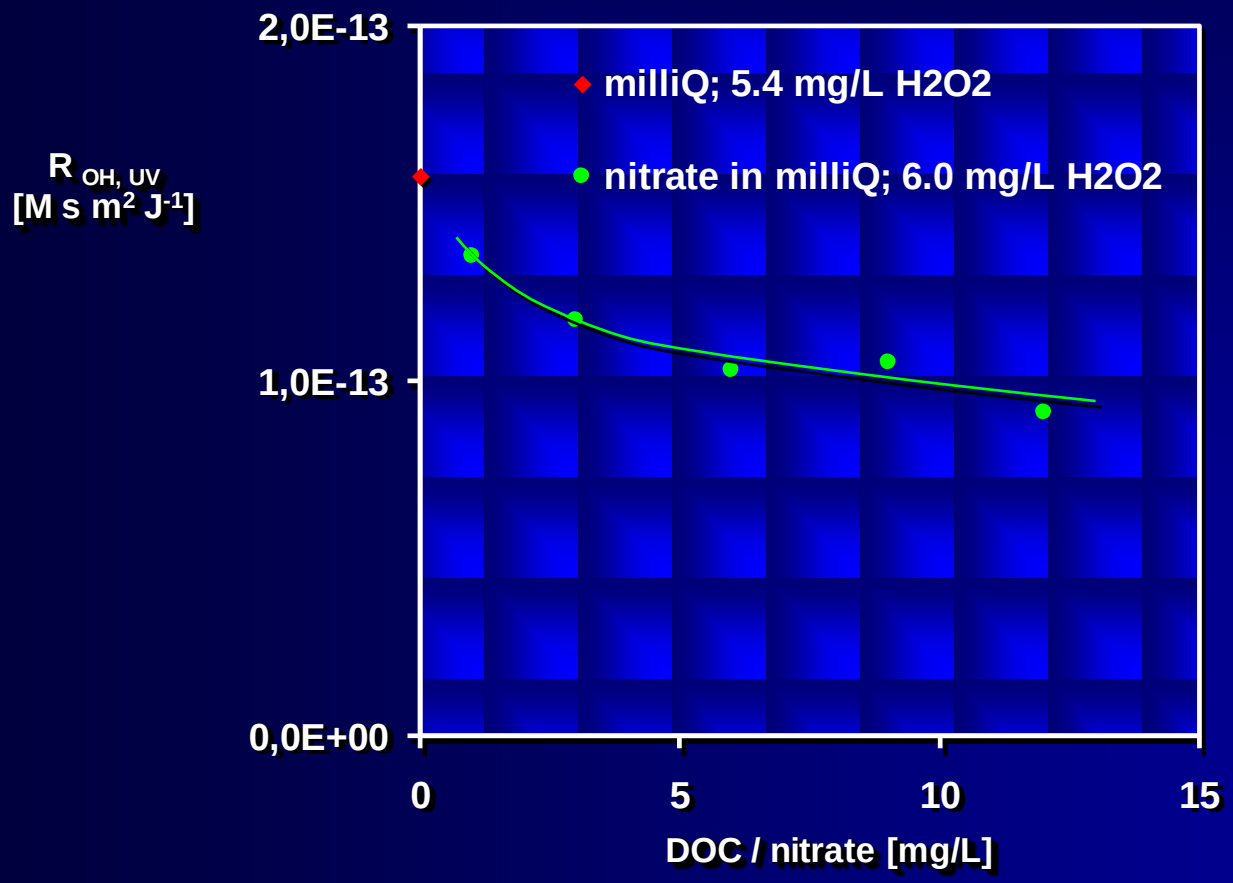

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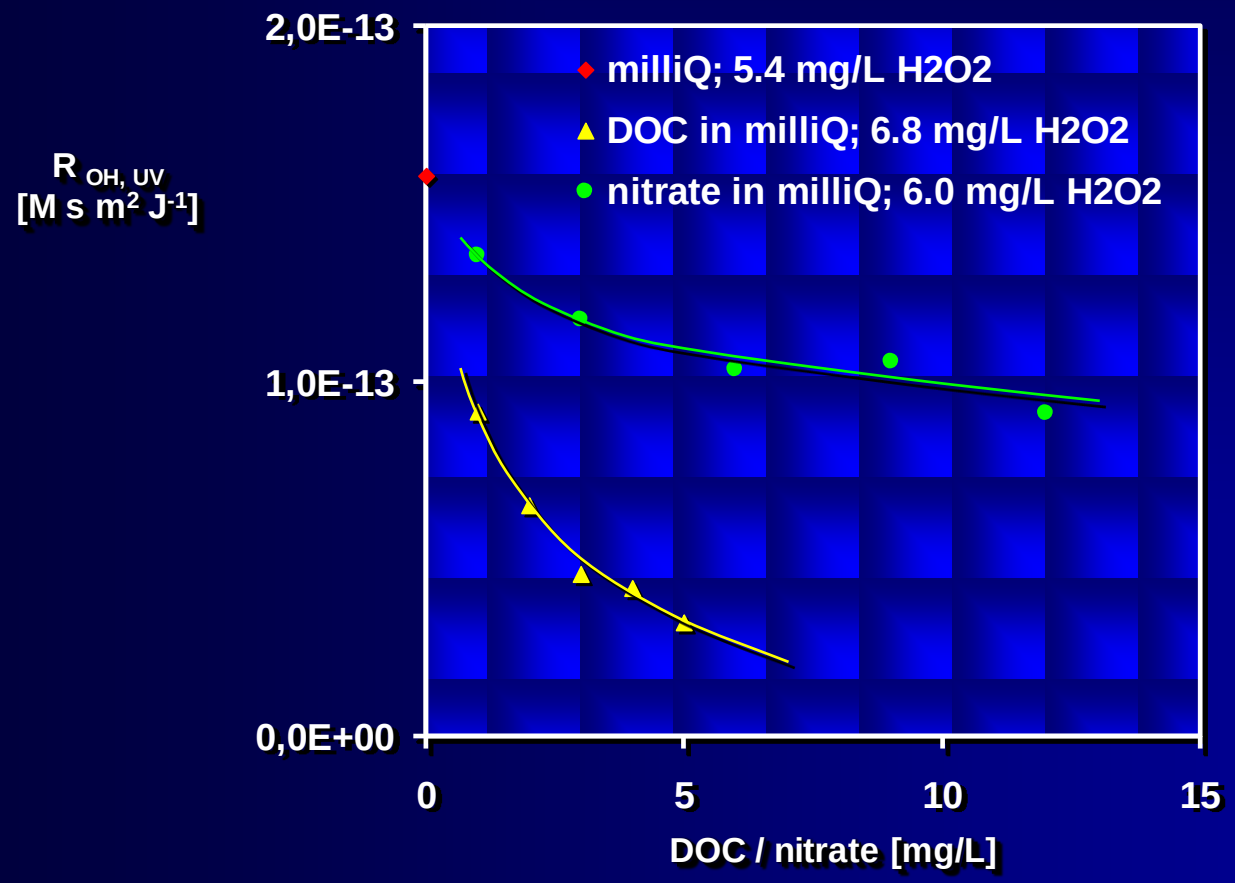


impact matrix on radical exposure

- superior radical exposure in milliQ water
- decrease radical exposure by matrix constituents NOM and nitrate

example:
‘robustness’ test with 2012 ‘priority’ compounds

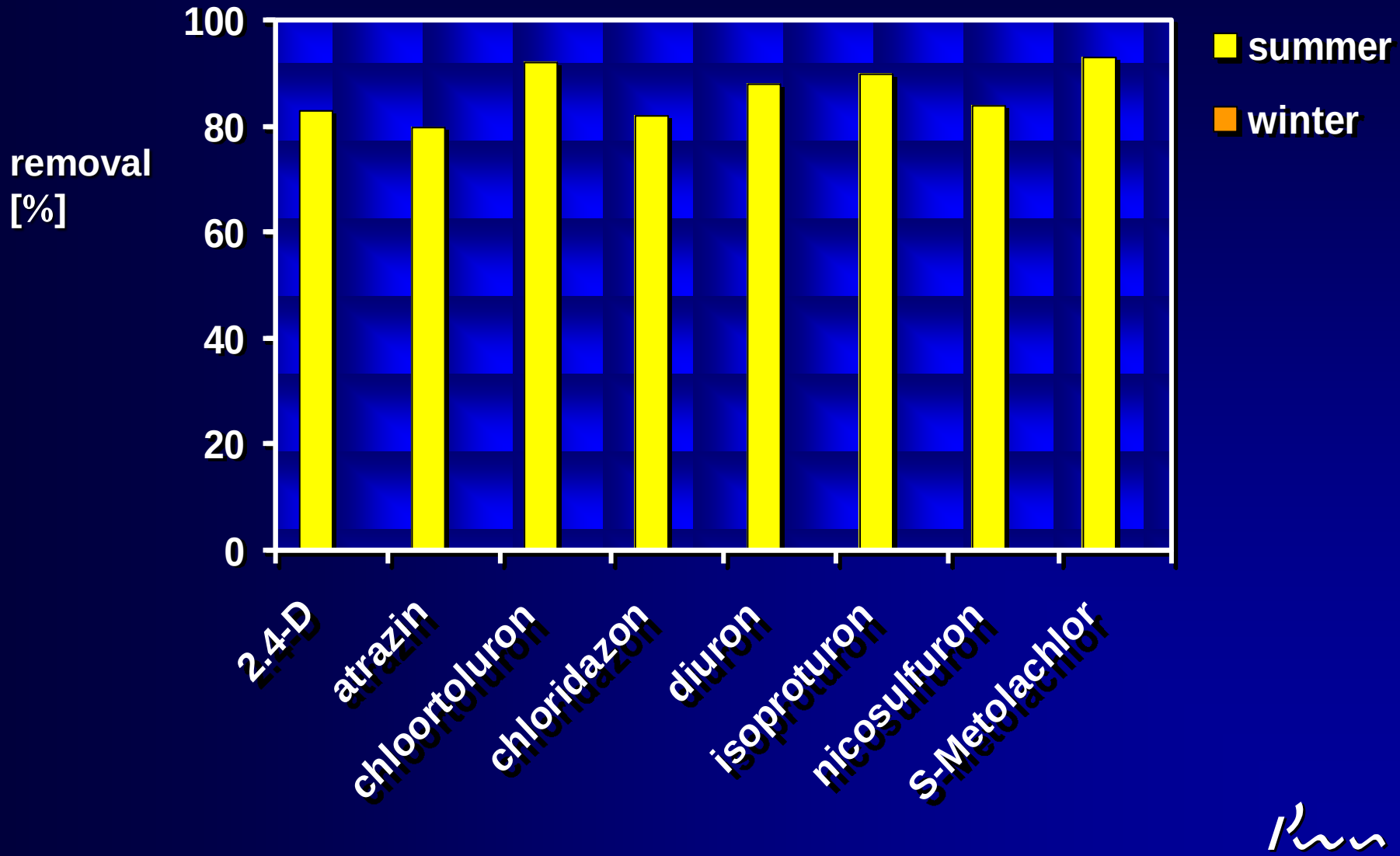
‘robustness’ test

- investigation in a 5 year cycle with priority compound selection

- selection 2012
  - herbicides
  - pharmaceuticals
  - industrial / other compounds
  - perfluorated compounds

- pilot scale with multiple barriers
  - UV/H_2O_2 0.54 kWh/m^3; 6 mg H_2O_2/L
  - GAC Norit ROW 0.8, EBCT 20 min

herbicide degradation by MP UV/H_2O_2 treatment



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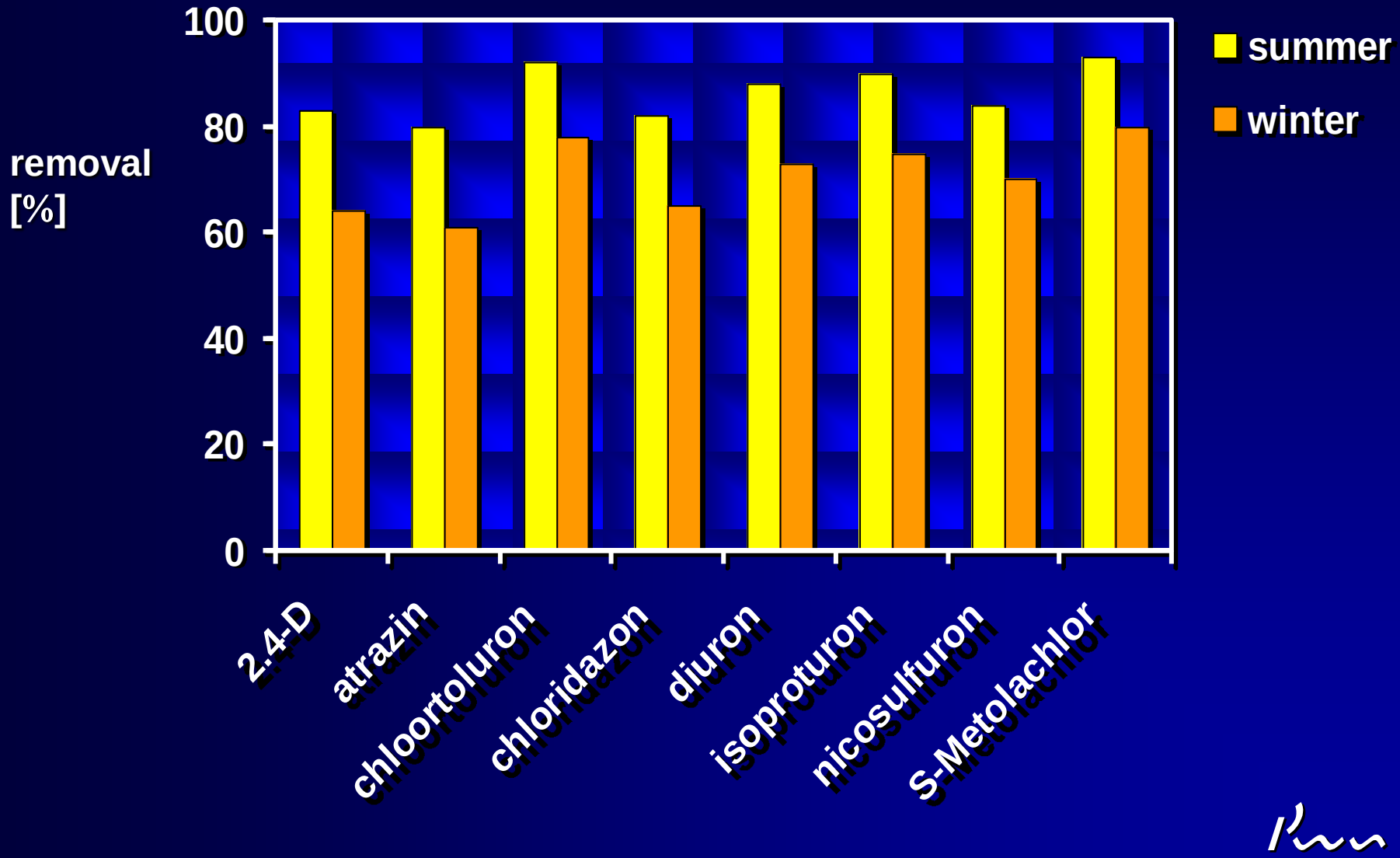
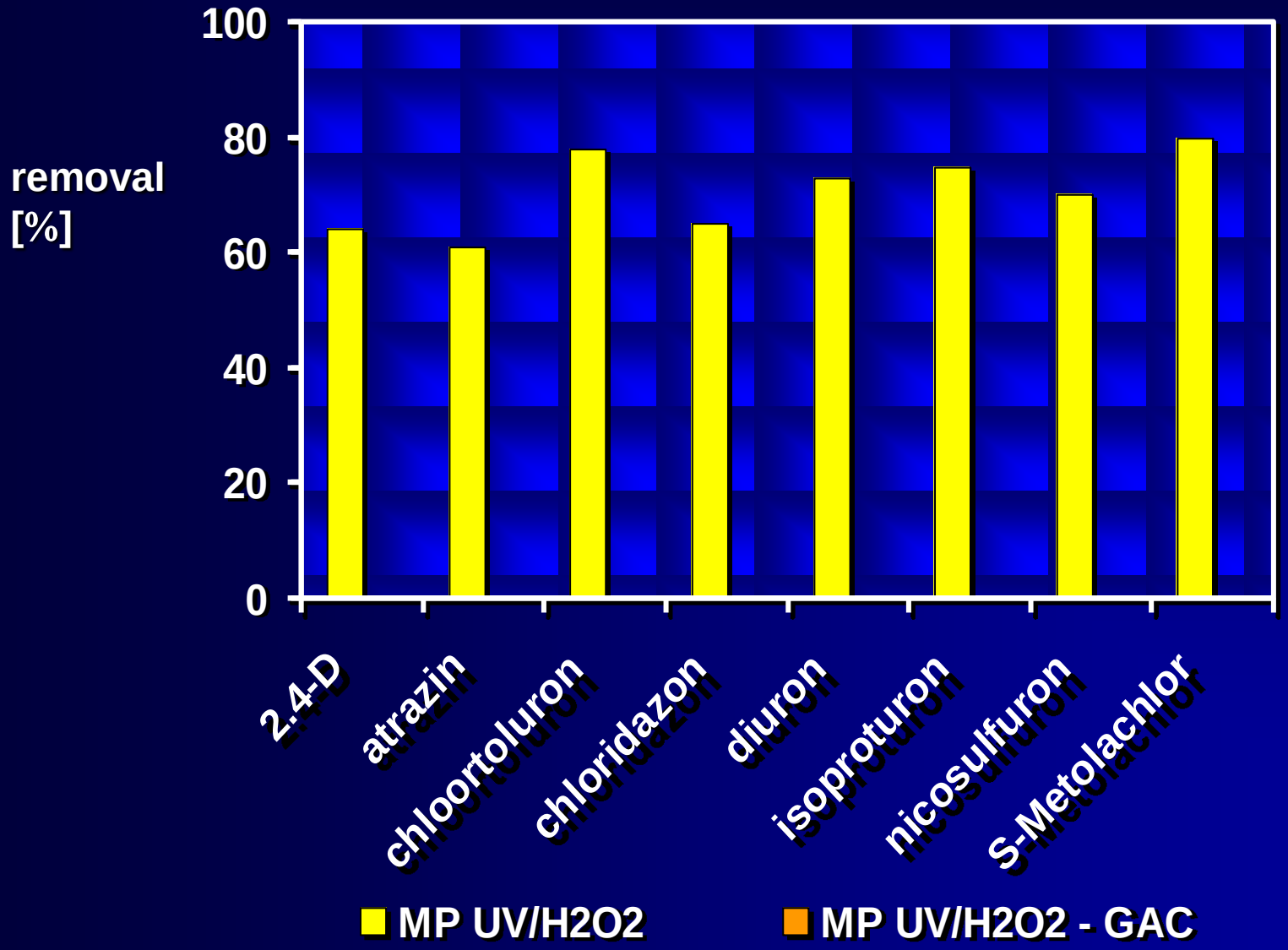


herbicide control by MP UV/H_2O_2 – GAC treatment



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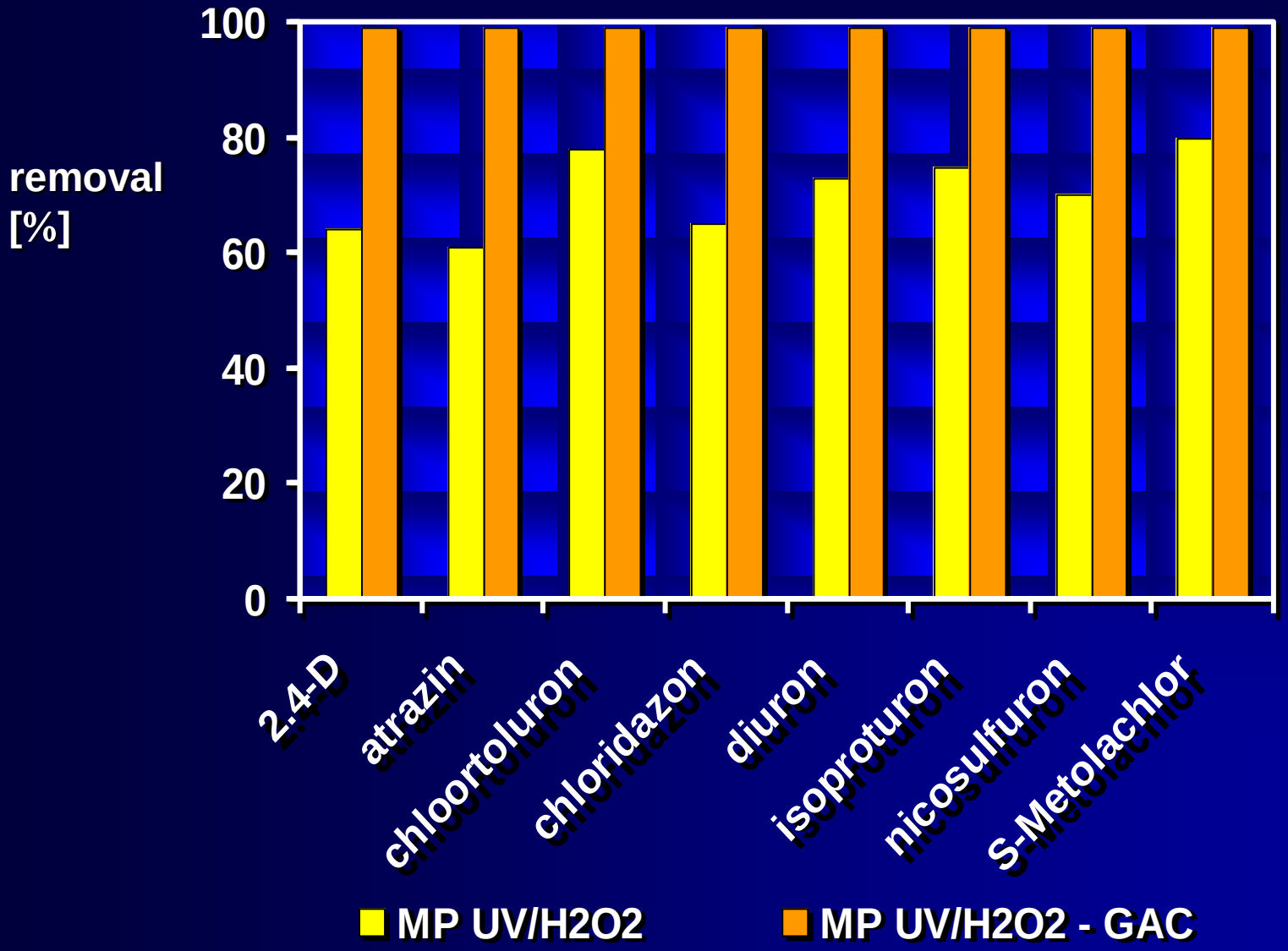
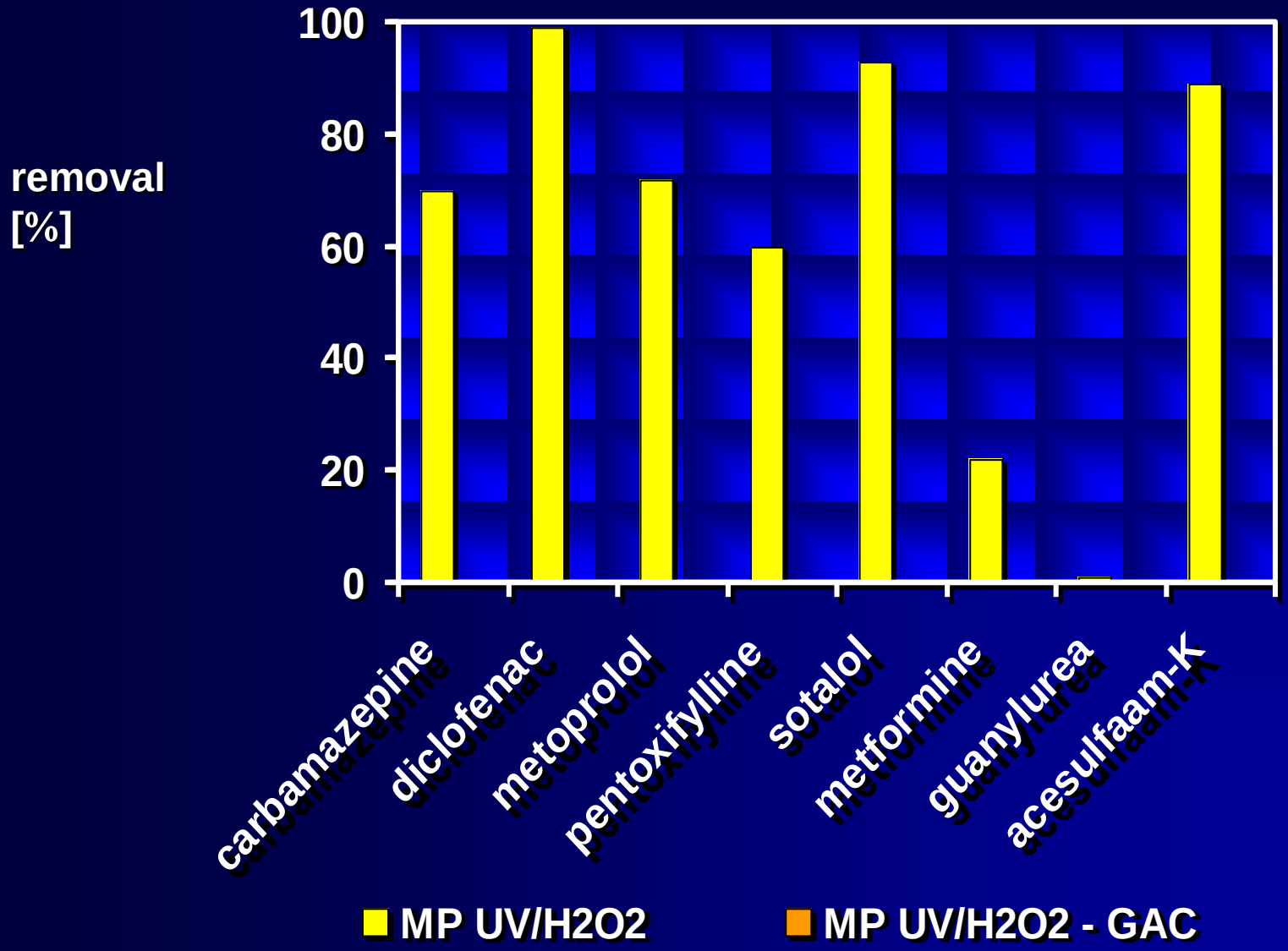


pharmaceutical control by MP UV/H_2O_2 – GAC treatment



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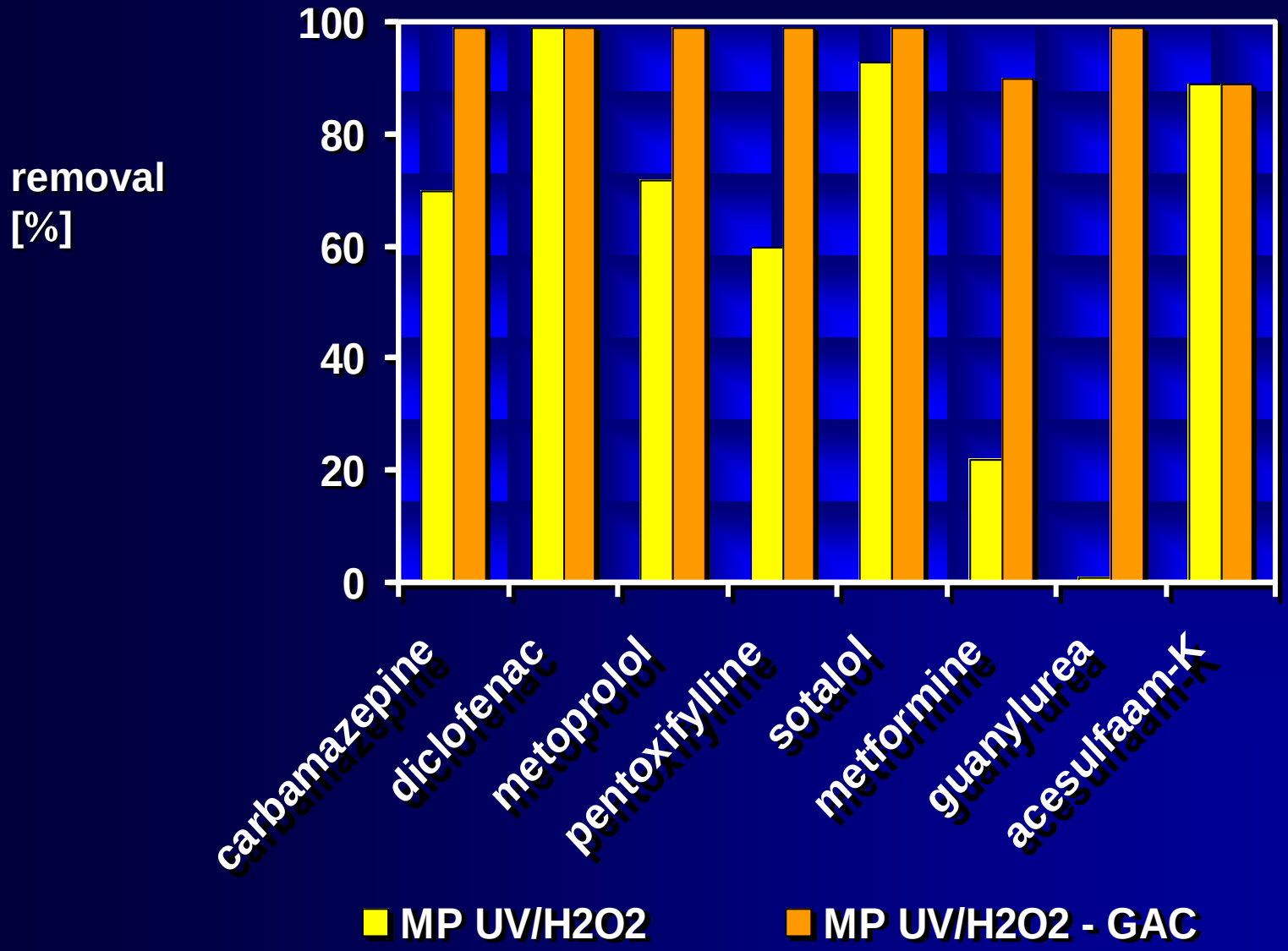
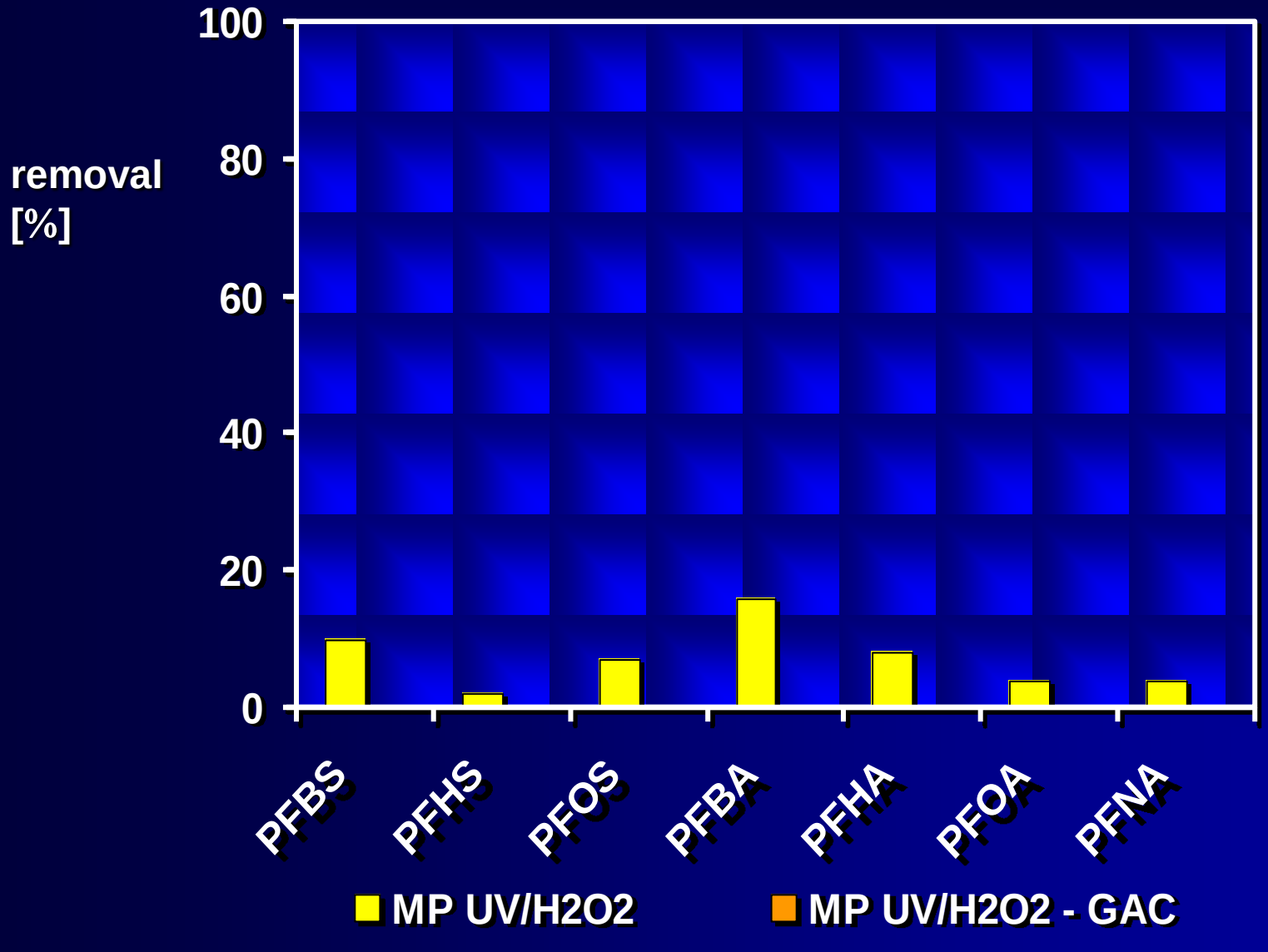


perfluorated compound control by MP UV/H_2O_2 – GAC treatment



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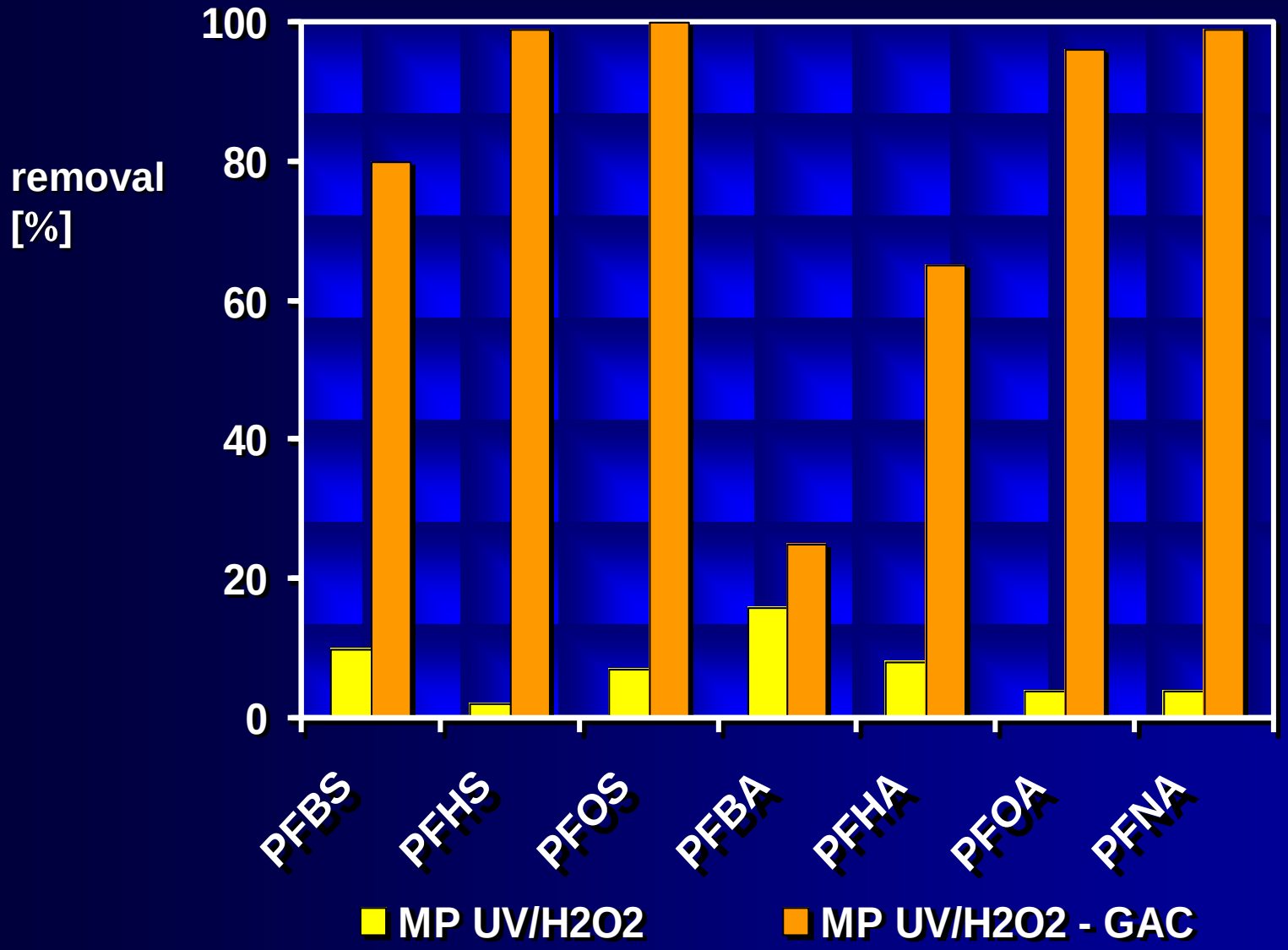

technology in summary

- combined advanced oxidation, adsorption and biological treatment (MP UV/H_2O_2 – BAC)

- at a certain cost
  - 0.54 kWh/m^3
  - 6 mg H_2O_2/L
  - 2 year reactivation frequency GAC

- can new classes of pollutants be treated equally succesful?

- are other technologies at other locations in the water cycle more efficient?

effect multiple barrier treatment on organic micropollutants

- non selective degradation trace chemical contaminants
- multibarrier approach with post treatment by (biological) GAC filtration very robust

but does this match the precautionary principle of the EU?

take home messages

- trace contaminants in drinking water sources via domestic waste water should not be a drinking water treatment problem only, anymore
- tailor available advanced drinking water treament technologies for complex waste water matrix
- modeling is essential in determining where to treat in the water cycle

acknowledgements

- KWR Water Cycle Research Institute
- HWL laboratory
- University of New Hampshire USA
- Trojan Technologies Canada
- Collegues at the Amsterdam Water Supply, The Hague Water Supply and PWN Water Supply Company North Holland